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Description

CLEANING SHEET

Technical Field:

[0001]

The present invention relates to a cleaning sheet particularly suitable to clean floors.

Background of Art:

[0002]

Various cleaning sheets having a fiber aggregate formed by hydroentangling a fiber web are known. In order to make cleaning sheets of this type with enhanced dust trapping capabilities, it is effective to increase the freedom of constituent fibers, which can be achieved by reducing the degree of entanglement of fibers. However, reduction in degree of fiber entanglement results in a reduction of sheet strength. It follows that the sheet easily sheds fibers during use. For example, the fibers caught on gaps or splinters of a wooden floor would easily be pulled out.

[0003]

In an attempt to accomplish both dust trapping capabilities and sheet strength, there have been proposed a number of cleaning sheets having a low degree of entanglement in which unidirectionally extending highly entangled regions are formed in stripes (see, for example, JP-A-2002-369782, JP-A-2003-508, and JP-A-2003-70707). These proposals have not yet accomplished sufficient prevention of fibers from coming off, still leaving room for further improvement.

Disclosure of Invention:

[0004]

The present invention provides a cleaning sheet having a fiber aggregate formed by hydroentangling a fiber web. The fiber aggregate has less entangled part having a low degree of fiber entanglement and highly entangled part having a higher degree of fiber entanglement than the less entangled part, the less entangled part being surrounded by the highly entangled part.

[0005]

The present invention also provides a preferred process for producing the cleaning sheet. The process includes the steps of hydroentangling a fiber web to form a less entangled fiber aggregate having a low degree of entanglement and further hydroentangling the less entangled fiber aggregate to form a highly entangled part having a higher degree of entanglement than the less entangled fiber aggregate and having a closed shape.

Brief Description of the Drawings:

[0006]

Fig. 1 is a perspective showing an essential part of an embodiment of the cleaning sheet according to the present invention.

Fig. 2 is a schematic illustration of a suitable apparatus for producing the cleaning sheet shown in Fig. 1.

Fig. 3 schematically illustrates an essential part of a highly entangling zone of the apparatus shown in Fig. 2.

Fig. 4 illustrates a pattern of forming highly entangled parts.

Fig. 5 illustrates another pattern of forming highly entangled parts.

Fig. 6 is a characteristic stress-strain curve.

Detailed Description of the Invention:

[0007]

The present invention will be described based on its preferred embodiments with reference to the accompanying drawings. Fig. 1 represents a perspective of an essential part of an embodiment of the cleaning sheet according to the present invention. The cleaning sheet 1 according to the present embodiment is composed of a fiber aggregate 2 formed by hydroentangling a fiber web and a lattice mesh sheet 3 disposed inside the fiber aggregate 2. The constituent fibers of the fiber aggregate 2 are entangled with the mesh sheet 3 by hydroentanglement so that the fiber aggregate 2 and the mesh sheet 3 are unitary.

[0008]

The fiber aggregate 2 is composed of less entangled parts 4 having a low degree of fiber entanglement and highly entangled parts 5 having a higher degree of

fiber entanglement than the less entangled parts 4. The highly entangled parts 5 have a smaller thickness than the less entangled parts 4. The less entangled parts 4 and the highly entangled parts 5 are practically equal in weight per unit area. This means that the less entangled parts 4 have a smaller density than the highly entangled parts 5.

[0009]

The individual less entangled parts 4 have a rhombic shape or a wavy shape. The highly entangled parts 5 are straight linear with an appointed width. The highly entangled parts 5 are arranged to make a lattice pattern. As is understood from Fig. 1, the individual less entangled parts 4 are surrounded by the highly entangled parts 5 except in the periphery of the sheet 1. In other words, the individual less entangled parts 4 are separated from one another by the highly entangled parts 5 and are independent from one another. The individual less entangled parts 4 do not always have to be completely surrounded by the highly entangled parts 5. That is, the highly entangled parts 5 may be dotted lines or composed of dots, by which the individual less entangled parts 4 is surrounded.

[0010]

In the less entangled parts 4 with a low degree of fiber entanglement, the constituent fibers have high freedom. Therefore, the less entangled parts 4 are able to efficiently catch up relatively large dust and debris including hairs and bread crumbs as well as fine dust. From this viewpoint, it is preferred for the fibers of the less entangled parts 4 to have a coefficient of fiber entanglement (hereinafter "entanglement coefficient") as small as 0.05 to 0.8 N·m/g, more preferably 0.1 to 0.7 N·m/g. The entanglement coefficient as referred to above, which is a measure representing the degree of entanglement of constituent fibers, is represented by the initial slope of the stress-strain curve measured in the direction perpendicular to the fiber orientation direction in the less entangled parts 4. The smaller the coefficient, the weaker the entanglement. The "fiber orientation direction" is a direction in which the maximum load in a tensile test is the highest, the "stress" is the quotient of a tensile load divided by the width of a specimen clamped in the tensile tester and the weight per unit area of the less entangled parts 4, and the "strain" means the amount of elongation.

[0011]

While the less entangled parts 4 primarily take part in dust collection and trapping as stated above, the highly entangled parts 5 primarily serve to prevent fibers from shedding. In cleaning with the sheet 1, the fibers making up the less entangled parts 4 are liable to be caught on angular parts, splinters, etc. of a surface to be cleaned and pulled out of the sheet 1 because of the low degree of fiber entanglement. To prevent this, the less entangled parts 4 are each surrounded by the highly entangled parts 5 so that the fibers constituting the less entangled parts 4 are firmly secured in the sheet by the highly entangled parts 5. The less entangled parts 4 being surrounded by the highly entangled parts 5, the fibers are prevented from shedding when the sheet 1 is slid on a surface to be cleaned in any planar direction of the sheet. That is, the cleaning sheet 1 of the present embodiment is not anisotropic with respect to the effect of preventing fibers from shedding. In contrast, because the cleaning sheets disclosed in JP-A-2002-369782, JP-A-2003-508, and JP-A-2003-70707 supra have regions corresponding to the highly entangled parts 5 of the present embodiment arranged in stripes extending in one direction, shedding of the fibers occurs easily when the sheets are slid in the same direction as the extending direction of the stripes.

[0012]

In order to securely prevent the constituent fibers from shedding, the entanglement coefficient of the highly entangled parts 5 is preferably as high as 0.81 to 3.0 N·m/g, more preferably 1.0 to 3.0 N·m/g.

[0013]

The area of the highly entangled parts 5 may be increased to prevent shedding of the constituent fibers. To excessively increase the area of the highly entangled parts 5, nevertheless, results in reduction of dust trapping capabilities of the sheet 1 as a whole because of the poor dust trapping capabilities of the highly entangled parts 5 compared with the less entangled parts 4. Conversely, to increase the area of the less entangled parts 4 enhances the dust trapping capabilities but, in turn, causes the fibers to come off more easily. Taking these points into consideration, the total area of the less entangled parts 4 in the sheet 1 (hereinafter also referred to as an area ratio) is preferably 80% to 98%, more preferably 85% to 95%, based on the area of the sheet 1.

[0014]

The area of the individual less entangled parts 4 is also influential on the dust trapping properties. With the entanglement coefficients being equal, a larger less entangled part 4 is more capable of dust trapping than a smaller one. This is because fibers are allowed to move a longer part thereof in a larger less entangled part 4 than in a smaller one. It is more advantageous, from the standpoint of enhancing the dust trapping capabilities, that the individual less entangled parts 4 have a larger area. Nevertheless, excessively increasing the area of the less entangled part 4 reduces the probability of the fibers of the less entangled part 4 being immobilized by the surrounding highly entangled parts 5, and the fibers are more apt to come off accordingly. From these perspectives, the area of the individual less entangled parts 4 is preferably 20 to 10000 mm^2, more preferably 200 to 5000 mm^2.

[0015]

Comparing between less entangled parts having the same area and the same entanglement coefficient but different shapes, the fibers are less liable to shed in a less entangled part with a less anisotropic shape than in one with a more anisotropic shape. From this viewpoint, it is preferred for the less entangled parts 4 to have as less anisotropic a shape as possible. The inventors' investigations have also revealed that the aspect ratio of the individual less entangled parts 4 is preferably 5 or smaller, more preferably 3 or smaller, which is sufficiently effective in preventing fiber shedding. Where the shapes of the less entangled parts are so complicated that their aspect ratios are not easy to calculate, the center of gravity of the less entangled part is located, and the ratio of the maximum to minimum diameters passing through the center of gravity is taken as an aspect ratio.

[0016]

The length of the constituent fibers also concerns shedding. Too short fibers have a reduced probability of being immobilized in the highly entangled parts 5 and are ready to shed. Therefore, longer fibers are more effectively protected from shedding. However, too long fibers can sometimes have difficulty in being formed into a web or entangled by hydroentanglement. From these perspectives, the length of the constituent fibers is preferably 30 to 70 mm, more preferably 35 to 65 mm. Where the fiber aggregate 2 is made up of two or more kinds of fibers, it is the most desirable for all the fibers to have lengths falling within the recited range. Nevertheless, the effect

of preventing fiber shedding would be sufficient only if the fibers of the kind that is used in a highest proportion satisfy the recited range of length.

[0017]

The cleaning sheet 1 of the present embodiment preferably has a "fiber shedding value" as small as 3 to 30, more preferably 4 to 15, measured by the method described later, in its less entangled parts 4. On the other hand, the fiber shedding value in the highly entangled parts 5 is still smaller than that, preferably from 0 to less than 3, more preferably 0 to less than 2.

[0018]

Materials composing the cleaning sheet 1 of the present embodiment will then be described. The fiber aggregate 2 of the sheet 1 contains fibers of a thermoplastic resin, such as a polyester resin, a polyamide resin or a polyolefin resin. Semisynthetic fibers such as cellulose acetate fibers, regenerated fibers such as cuprammonium and rayon, and natural fibers such as cotton are also usable. These fibers may be used in combination. The fiber aggregate 2 preferably contains heat fusible fiber. Preferably used as heat fusible fiber are sheath/core conjugate fiber having a high melting polymer as a core and a low melting polymer whose melting point is lower than that of the high melting polymer by at least 10°C as a sheath and side-by-side conjugate fiber composed of a high melting polymer and a low melting polymer bonded side by side. High melting polymer/low melting polymer combinations that make conjugate fibers include polypropylene/polyethylene, polyethylene terephthalate/polyethylene, and high melting polyester/low melting polyester.

[0019]

The fiber aggregate 2 preferably weighs 30 to 100 g/m^2, more preferably 40 to 70 g/m^2. A surface active agent or a lubricant that can improve the dust trapping capabilities may be applied to the fiber aggregate 2.

[0020]

The mesh sheet 3 includes a lattice net made of a thermoplastic resin, e.g., polypropylene. The mesh sheet 3 preferably has a monofilament diameter of 50 to 600 μm, more preferably 100 to 400 μm, and an aperture width of 2 to 30 mm, more

preferably 4 to 20 mm. The mesh sheets illustrated in commonly owned Japanese patent application, JP-A-7-184815, Figs. 4(a) to 4(c) are also employable. The mesh sheet 3 can be made of heat shrinkable material. In this case, the mesh sheet may be subjected to heat treatment in the manufacture of the sheet 1 to give a sheet 1 with a larger apparent thickness. The mesh sheet may be replaced with nonwoven fabric, paper, perforated film, or the like. Spunbonded nonwoven fabric is a preferred nonwoven fabric.

[0021]

A preferred embodiment of the process of producing the cleaning sheet 1 according to the above embodiment will be described by way of Figs. 2 and 3. The process of producing the cleaning sheet 1 of the present embodiment includes, in the order described, the step of superposing an upper fiber subweb 2a and a lower fiber subweb 2b on the upper and lower sides of the mesh sheet 3, respectively, the step of hydroentangling the constituent fibers of the fiber subwebs 2a and 2b not only with one another to form a less entangled fiber aggregate but also with the mesh sheet 3 to form a less entangled fiber structure 6 in which the fibers and the mesh sheet 3 are united, and the step of further hydroentangling the less entangled fiber aggregate to form highly entangled parts having a higher degree of fiber entanglement than the less entangled fiber aggregate and having a closed shape.

[0022]

Fig. 3 illustrates an apparatus 10 that is preferably used to produce the cleaning sheet 1 of the present embodiment. The apparatus 10 is sectioned into a superposing zone 10A, a less entangling zone 10B, a highly entangling zone 10C, and a drying zone 10D.

[0023]

In the superposing zone 10A, a fiber subweb 2a and a fiber subweb 2b are fed from carding machines 11A and 11B, respectively. A roll 12 of a mesh sheet 3 is set between the carding machines 11A and 11B, from which the mesh sheet 3 is unrolled. The fiber subwebs 2a and 2b are superposed on both sides of the mesh sheet 3 to make a laminate 7.

[0024]

In the less entangling zone 10B, the laminate 7 is wrapped around a drum 13a, the peripheral surface of which is formed of a water permeable material such as wire mesh or punching metal. In this state, the laminate 7 is entangled with high-pressure water streams from first water jet nozzles 14a placed to face the peripheral surface of the drum 13a. The entanglement is effected from one side of the laminate 7. As a result, the constituent fibers of the fiber subwebs 2a and 2b in the laminate 7 are intermingled with one another to form a fiber aggregate having a low degree of entanglement. At the same time, the constituent fibers are entangled with the mesh sheet 3. There is thus obtained a less entangled structure 6 having the three members united into one body. The pressure of the water streams is controlled appropriately so as to provide a fiber aggregate with a low degree of entanglement. While varying depending on the weight per unit area of the fiber aggregate, a desired degree of entanglement is obtained by applying water streams at a water pressure of about 1.0 to 8.0 MPa.

[0025]

The less entangled structure 6 is conveyed on an endless belt 15, inverted, and further intermingled by high-pressure water streams from second water jet nozzles 14b. The second entanglement is effected from the reverse side of the first hydroentangled side. The hydroentanglement is carried out with the structure 6 wrapped around a drum 13b that is structurally similar to the drum 13a. The water pressure of the water streams can be the same as that used in the first hydroentanglement. By conducting hydroentanglement from both sides of the laminate, the resulting cleaning sheet is to have the same degree of entanglement on both sides thereof.

[0026]

After the second hydroentanglement, the less entangled structure 6 is conveyed on an endless belt 16 made of a water permeable material and dewatered by suction boxes 17 to remove excess water. The less entangled structure 6 is inverted again and introduced into the highly entangling zone 10C. The highly entangling zone 10C has an endless belt 18 made of a water permeable material for conveying the less entangled structure 6. Nozzle heads 19a and 19b are placed above the endless belt 18. Suction boxes 20 are disposed opposite to the nozzle heads 19a and 19b with respect to the

endless belt 18.

[0027]

Fig. 3 is a close-up of an essential part of the highly entangling zone 10C. The highly entangling zone 10C has two nozzle heads 19a and 19b, each having a large number of jet nozzles 21 aligned in the direction perpendicular to the conveying direction of the less entangled structure 6 (indicated by the arrow in Fig. 3). The nozzle head 19a is located upstream of the nozzle head 19b. Both the nozzle heads 19a and 19b are structured to reciprocate in the direction perpendicular to the conveying direction of the less entangled structure 6. The jet nozzles 21 are equally spaced in each of the nozzle heads 19a and 19b.

[0028]

In the highly entangling zone 10C, high pressure water streams are jetted from the jet nozzles 21 arranged in the nozzle heads 19a and 19b which are reciprocating in the direction perpendicular to the conveying direction of the less entangled structure 6 and struck against the less entangled structure 6 moving in the direction indicated by the arrow in Fig. 4. The less entangled structure 6 is thus further hydroentangled to form the highly entangled parts 5 that have a higher degree of entanglement than the less entangled structure 6 and each have a closed shape. The regions closed by the highly entangled parts 5, where the hydroentanglement has not been applied in the highly entangling zone 10C, retain the less entangled state to provide the less entangled parts 4. While depending on the weight of the fiber aggregate, a satisfactory degree of highly entangling is reached by jetting the water streams at a water pressure of about 2.0 to 15.0 MPa

[0029]

The nozzle heads 19a and 19b move reciprocally over the same length at the same speed but in opposite directions. The cycle of the reciprocating movement of one of the nozzle heads is out of phase with that of the other one by one half cycle. When the reciprocating motion of each of the nozzle heads 19a and 19b is at a constant velocity, the nozzle head 19a forms highly entangled parts 5a in a sine wave pattern shown in Fig. 4, and the nozzle head 19b forms highly entangled parts 5b in a sine wave pattern shown in the same drawing. Combining the two sine wave patterns gives a

finally obtained pattern of the highly entangled parts 5, which is shown in Fig. 4.

[0030]

In order to form the highly entangled parts 5 in a lattice pattern illustrated in Figs. 1 and 3, the nozzle heads 19a and 19b are reciprocated at a variable velocity. In this case, the nozzle head 19a forms the highly entangled parts 5a in a triangular wave pattern shown in Fig. 5, while the nozzle head 19b forms the highly entangled parts 5b in a triangular wave pattern shown in the same drawing. Combining the two triangular wave patterns results in a finally obtained pattern of the highly entangled parts 5, which is also shown in Fig. 5.

[0031]

There is thus obtained the cleaning sheet 1 having the fiber aggregate 2 which includes the less entangled parts 4 and the highly entangled parts 5. The sheet 1, which has been dewatered by the suction boxes 20 but is still wet in this stage, is introduced into the drying zone 10D, where it is further freed of water into a dry state to obtain a desired cleaning sheet 1.

[0032]

The resulting cleaning sheet is particularly suited to clean flooring such as wooden floors. It is also useful to clean furniture, such as relatively wide tables and desks, and appliances, such as TV sets, video cassette recorders, and refrigerators.

[0033]

The present invention is not limited to the aforementioned embodiments. For example, the less entangled parts 4, which have the same shape in the foregoing embodiments, may have different shapes.

[0034]

While in the foregoing embodiments the fiber aggregate 2 has the mesh sheet 3 disposed therein, the mesh sheet is not always necessary as long as shape retention and strength are secured as desired. Since the sheet 1 of the present embodiment, in particular, has highly entangled parts 5 functioning to maintain strength and shape retention, it is able to retain shape retention and strength as desired without using the

mesh sheet 3.

[0035]

While in the foregoing embodiments the sheet 1 has a practically flat surface with no projections nor depressions on both sides, the cleaning sheet of the invention may be obtained by forming less and highly entangled parts using a sheet with a large number of projections and depressions, such as the one disclosed in commonly owned patent application WO 01/71081, the disclosures of which are incorporated herein by reference.

[0036]

While in the above-described process of production, the highly entangled parts 5 of closed shape are formed in a continuous production line, the closed shape may be formed otherwise. That is, the less entangled structure 6 is first hydroentangled in a pattern of equally spaced straight or wavy lines extending in the same direction to form a first group of highly entangled parts. Either after once winding up or subsequently, the conveying direction of the less entangled structure 6 having the first group of highly entangled parts is changed (for example, by 90°), and the less entangled structure 6 is hydroentangled in a pattern of equally spaced straight or wavy lines extending in the same direction to form a second group of highly entangled parts that intersect with the first group of highly entangled parts.

EXAMPLES

[0037]

The present invention will now be illustrated in greater detail with reference to Examples, but it should be understood that the invention is not construed as being limited thereto. Unless otherwise noted, all the percents are by weight.

[0038]

EXAMPLE 1

Polyester fiber (1.3 denier (1.4 dtex) x 38 mm/2.0 denier (2.2 dtex) x 51 mm = 70%/30%) was carded in a usual manner into a fiber web weighing 27 g/m^2. A polypropylene lattice net (aperture width: 8 mm; monofilament width: 300 μm) was used as a mesh sheet. The fiber webs were superposed on each side of the mesh sheet

and intermingled by water streams ejected from nozzles under a water pressure of 1 to 5 MPa to obtain a less entangled, unitary structure having a fiber aggregate.

[0039]

The less entangled structure was further hydroentangled to form a first group of equally-spaced, parallel, straight-linear highly entangled parts. The width of each highly entangled part was 2 mm. The pitch of the highly entangled parts was 40 mm. The water pressure of the water streams was 2 to 15 MPa. The highly entangled parts were formed in a direction making an angle of 45° with the machine direction of the less entangled structure. Subsequently, a second group of straight-linear highly entangled parts intersecting the first group of the highly entangled parts at right angles were formed under the same hydroentangling conditions. The width and the pitch of the second group of the highly entangled parts were the same as those of the first group. There was thus produced a sheet having diamond-shaped, less entangled parts delineated by the highly entangled parts. A 9:1 (by weight) mixture of liquid paraffin and a nonionic surfactant (polyoxyethylene alkyl ether) was applied to the sheet as an oil in an amount of 5 wt% to obtain a cleaning sheet.

[0040]

After the resulting cleaning sheet was dried, an oil consisting of 90% of liquid paraffin and 10% of a nonionic surfactant (polyoxyethylene alkyl ether) was applied to the sheet in an amount of 5 wt%.

[0041]

EXAMPLE 2

Polyester fiber (1.3 denier (1.4 dtex) x 38 mm) was carded in a usual manner to obtain a fiber web weighing 29 g/m^2. Highly entangled parts each having a width of 2 mm were formed at a pitch of 30 mm in both the machine and cross directions of the less entangled structure. A cleaning sheet was obtained in otherwise the same manner as in Example 1.

[0042]

COMPARATIVE EXAMPLE 1

A cleaning sheet was obtained in the same manner as in Example 2, except that

the fiber web was hydroentangled under a water pressure condition of 2 to 15 MPa to obtain a highly entangled structure. Regional formation of highly entangled parts was not conducted.

[0043]

COMPARATIVE EXAMPLE 2

A cleaning sheet was obtained in the same manner as in Example 1, except that the hydroentanglement for forming highly entangled parts was not conducted on the less entangled structure.

[0044]

Evaluation:

The cleaning sheets obtained in Examples and Comparative Examples were measured for the area and area ratio of the less entangled parts. The entanglement coefficients of the less and highly entangled parts were measured as follows. Furthermore, the cleaning sheets were evaluated or measured for dust trapping capabilities, hair trapping capabilities, yarn trapping capabilities, amount of shed fibers, and fiber shedding value in accordance with the following methods. The evaluation of dust trapping capabilities was carried out by using seven types of dust The results obtained are shown in Table 1.

[0045]

(1) Entanglement coefficient

A 15 mm wide specimen was cut out from each of the less entangled part and the highly entangled part from both of which the lattice net had been removed. The specimen was cut with its length perpendicular to the fiber orientation direction of the fiber aggregate. The specimen was set on a tensile tester at a chuck distance of 50 mm and pulled in the direction perpendicular to the fiber orientation direction at a speed of 30 mm/min to record the tensile load vs. elongation. The tensile load F (g) was divided by the width (m) of the specimen and the weight per unit area (g/m^2) of the fiber aggregate to give a stress S (m), from which a stress-strain (elongation) curve was plotted.

Stress S (m) = (F/0.015)/W

[0046]

The fiber aggregate constructed only by entanglement of fibers shows a linear relationship between stress and strain (elongation) for small strains. The slope of the straight line is obtained as an entanglement coefficient E (m). In the stress-strain (elongation) presented in Fig. 6, for instance, in which P is the proportional limit, S_P is the stress at P, and γ_P is the strain (elongation) at P, the entanglement coefficient is represented by equation: $E = S_P/\gamma_P$ (when $S_P = 60$ m and $\gamma_P = 86\%$, $E = 60/0.86 = 70$ m). The segment OP may not be exactly straight, in which case it should be approximated to a straight line segment.

[0047]

(2) Dust trapping capabilities

The sheet was attached to a sweeper Quickle Wiper (from Kao Corp.). As model dust, JIS test powder class 7 (fine particles of the Kanto loam) weighing 0.03 g was uniformly spread on a 90 cm x 90 cm area of a wooden floor (Woodytile MT613T, from Matsushita Electric Works, Ltd.) with a brush. The dusted area of the floor was cleaned by giving three parallel, forward and backward sweeps of Quickle Wiper. The same sweeping operation was repeated from the opposite side of the dusted area. Thereafter, any remaining dust was removed from the floor, and the same cycle of cleaning operations was repeated for a total of four times. The weight of dust trapped by the sheet was obtained by subtracting the weight of the intact sheet before cleaning from the weight of the soiled sheet. The weight of dust trapped was divided by the total weight of the dust spread (0.12 g = 4 x 0.03 g), and the quotient was multiplied by 100 to give a dust trapping ratio (%). Cleaning sheets having a dust trapping ratios of 60% or higher are judged to have satisfactory dust trapping capabilities. In Table 1 dust trapping ratios of 60% or higher and those lower than 60% are shown together with the rating "good (G)" or "poor (P)", respectively.

[0048]

(3) Hair trapping capabilities

The sheet was attached to a sweeper Quickle Wiper (from Kao Corp.). Ten human hairs of about 20 cm in length were scattered over a 30 cm by 60 cm area of a wooden floor (Woodytile MT613T, from Matsushita Electric Works, Ltd.). The area was swept forward and backward each once with Quickle Wiper over a given length

(60 cm), and the number of hairs caught on the sheet was counted. The same operation was carried out three times to count how many hairs out of 30 were caught up. The total number of hairs caught up was divided by 30, and the quotient was multiplied by 100 to give a hair trapping ratio (%). Cleaning sheets having a hair trapping ratios of 80% or higher are judged to have satisfactory hair trapping capabilities. In Table 1 hair trapping ratios of 80% or higher and those lower than 80% are shown together with the rating "good (G)" or "poor (P)", respectively.

[0049]

(4) Yarn trapping capabilities

The sheet was attached to a sweeper Quickle Wiper (from Kao Corp.). Three millimeter long cut pieces of commercially available 100% acrylic yarn weighing 0.5 g were evenly scattered on a 360 cm x 270 cm wooden floor (Woodytile MT613T, from Matsushita Electric Works, Ltd.) using a sieve. Every floor area corresponding to one-tatami size (90 cm x 180 cm) was divided into 12 sections, and a single forward-and-backward sweep with Quickle Wiper was made on every divided section. After cleaning all the divided sections, the amount (g) of yarn caught up on the sheet was obtained by subtracting the weight of the intact sheet before sweeping from the weight of the sheet after sweeping. The percentage of the weight of the yarn trapped to the weight of the yarn scattered (0.5 g) was taken as a trapping ratio (trapping ratio (%) = amount of yarn trapped (g)/0.5 g x 100). Cleaning sheets having a trapping ratios of 65% or higher are judged to have satisfactory yarn trapping capabilities. In Table 1 yarn trapping ratios of 65% or higher and those lower than 65% are shown together with the rating "good (G)" or "poor (P)", respectively.

[0050]

(5) Amount of shed fibers

The sheet was attached to a sweeper Quickle Wiper (from Kao Corp.). A 30 cm by 60 cm area of a wooden floor (KEC6015F, from Matsushita Electric Works, Ltd.) was cleaned by giving 100 forward and backward sweeps with the sweeper along the longitudinal joints between the floorboards. After the cleaning, loose fibers shed from the sheet were collected from the floor and weighed. When the weight is 8 mg or less, the amount of shed fibers is judged to be sufficiently small. In Table 1 amounts of shed fibers of 8 mg or less and those more than 8 mg are shown together with the

rating "good (G)" or "poor (P)", respectively.

[0051]

(6) Fiber shedding value

The cleaning sheet to be tested and adhesive tape used in testing were previously conditioned in an environment of 20°C to 25°C and 50% to 70% RH for at least 24 hours. The test was performed in an environment of 20°C to 25°C and 50% to 70% RH.

[0052]

A 3 mm x 50 mm strip was cut out of kraft tape No. 712 available from Nitto Denko Corp. (Ibaraki-shi, Osaka, Japan). The strip was folded with the adhesive side inward to prepare a testing strip for adhesive tape test having a 3 mm x 3 mm adhesive part and a 3 mm x 23.5 mm non-adhesive part (tab).

[0053]

The cleaning sheet to be tested was placed on a flat horizontal surface. The testing strip was softly put on the cleaning sheet with its longer sides parallel to the MD of the sheet. The location of the testing strip should be at least 1 cm away from any edge of the sheet. A roller was rolled on the testing strip from the non-adhesive tab to the adhesive part to stick the adhesive side to the cleaning sheet. The roller has a width of 33 mm and a weight of 1200 g. After the roller rolls beyond the adhesive part, it was rolled back until it rolled past the non-adhesive tab. This forward and backward rolling operation was conducted 10 times. The roller was rolled at a speed of 1.5 cm/s. The roller was rolled by pulling the handle held horizontally (i.e., parallel to the surface) so as to avoid imposing an upward or downward force induced by an operator.

[0054]

After the rolling operation, the testing strip was peeled off the cleaning sheet as follows. While the cleaning sheet was held by the sides of the testing strip, the non-adhesive tab was picked up by one hand and pulled straight upward (at a right angle from the surface) by applying a constant force to peel the strip off the sheet in 2 seconds. The adhesive part of the strip was observed with a magnifier to count the

fibers adhered thereto.

[0055]

The same adhesive tape test was carried out nine more times on the same cleaning sheet using a new testing strip for every test for a total of ten runs per sheet. The numbers of fibers adhered to the ten testing strips were averaged to give a fiber shedding value.

[0056]

TABLE 1

		Example		Comp. Example	
		1	2	1	2
Area of Less Entangled Parts (mm^2)		1444	784	0	-
Area Ratio of Less Entangled Parts (%)		90	87	0	100
Entanglement Coefficient of Less Entangled Parts (Nm/g)		0.3	0.2	-	0.3
Entanglement Coefficient of Highly Entangled Parts (Nm/g)		1.6	1.4	0.81	
Trapping Capabilities (%)	Dust	61(G)	62(G)	62(G)	65(G)
	Hair	95(G)	80(G)	30(P)	80(G)
	Yarn	66(G)	68(G)	60(P)	72(G)
Amount of Shed Fibers (mg)		3.6(G)	5.9(G)	7.7(G)	15.3(P)
Fiber Shedding Value of Less Entangled Parts		4	7	-	22
Fiber Shedding Value of Highly Entangled Parts		0	1	3	-

Note: "Area of less entangled parts (mm^2)" is the area of the individual less entangled parts.

[0057]

As is apparent from the results shown in Table 1 above, it is seen that the cleaning sheets of Examples are equal or superior in dust trapping performance to the comparative cleaning sheets and cause far less shedding of fibers than the comparative cleaning sheets.

Industrial Applicability:

[0058]

The cleaning sheet according to the present invention efficiently pickup not only fine dust but relatively large dust and debris including hairs and bread crumbs and is yet prevented from shedding the constituent fibers during use for cleaning.